general surface; a property which we have seen to exist in all parts of the posterior bulb.

This pretty and interesting, though minute, Actinoid was found at Torquay in July by Miss Pinchard, an accomplished student of our marine natural history. This lady kindly forwarded it to me in its own native nidus,—an old *Saxicava's* burrow in the limestone rock, out of which its fore-parts projected (see fig. 2). Though removed from its burrow for the purpose of examination, it has lived several weeks in one of my small aquaria, expanding at intervals (somewhat charily), and frequently adhering to the glass by its posterior bulb.

EXPLANATION OF PLATE IX.

Fig. 1. *Edwardsia carnea*: natural size.
Fig. 2. *Ibid.* (magnified), in the act of protruding.
Fig. 3. *Ibid.* (magnified); the anterior column protruded and expanded.
Fig. 4. *Ibid.* (magnified); the posterior bulb protruded.

XXI.—*Notes on the Freshwater Infusoria of the Island of Bombay.* No. 1. *Organization.* By H. J. Carter, Esq., Assistant Surgeon H.C.S., Bombay.

[Concluded from p. 132.]

Nucleus.—By this term we shall understand, for the most part, an organ situated in the outer portion of the sarcode, which, when well marked, presents under the microscope the appearance of a full moon (to use a familiar simile), with similar slight cloudinesses (figs. 1 *d*, 2 *e*, 3 *d*). It is discoid in shape, of a faint yellow colour, and fixed to one side of a transparent capsule, which, being generally more or less large than the nucleus itself, causes the latter to appear as if surrounded by a narrow pellucid ring. In this state it is invariably present in *Amœba*, *Actinophrys*, *Spongilla*, *Astasia* (fig. 45 *b*), and *Euglena* (figs. 46 *a*, &c.), though difficult at first to recognise; particularly in the two latter families, where the pellucid space or capsule, at the bottom of which it is situated, is often the only visible sign of its presence. In *Difflugia proteiformis* it cannot of course be seen, from the thickly incrusted state of the test; but in a smaller and less incrusted species, which might be called *D. tricuspis* (from the trefoil-form of the opening of the test) (fig. 80), as well as in *Euglypha*, its position is posterior, and evident, from the largeness of the capsule, though the nucleus itself is so faint that even in *Euglypha* it can only occasionally be distinguished; while in *Arcella vulgaris* (Ehr.) it is constantly double and opposite (fig. 79). In *Amœba Gleichenii* the nucleus itself occasionally presents a pellucid spot or punctum in its centre.

In *Vorticella* there is a long cylindrical organ, which appears analogous to, if not homologous with, the nucleus, and this, in a large *Epistylis* common here, and some other species of *Vorticella,* is wrapped once round the upper part of the buccal cavity, in the same manner as the ovary is wrapped round the visceral organs of *Salpa* among the Tunicata (fig. 74 *g*). Stein states that after *Vorticella microstoma* has become encysted, this organ divides up into embryos, which, when the parent integument bursts, come forth like "*Monas colpoda* or *Monas scintillans*"; and he "assumes" that these monads, after having become fixed and stalked, pass into young *Vorticellæ**;—an assumption which can hardly be doubted, though it may be some time before chance favours its demonstration.

In *Otostoma,* and many forms of Ehrenberg's Enterodelous class of animalcules, there is a similar organ, either of a circular, cylindrical, or fusiform, elongated shape (Annals, vol. xvii. pl. 9. fig. 6). In *Oxytricha* also there is something of the kind, and in *Himantophorus* (*Charon,* Ehr., mihi) it extends nearly all round the body, commencing from the posterior extremity, and terminating on the right side close to the vesicula.

The cylindrical organ in *Vorticella* not unfrequently presents a granular appearance, and the granules, which are minute, but uniform in size, appear to occupy the periphery; but whether they are inside or outside the wall of the cylinder, or in the substance of the wall itself, I have not been able to determine. Stein places them inside, in the form of a granular cylinder, and within this "nucleoli †,"—nucleated, discoid bodies, into which the nucleus becomes divided.

In the Rhizopodous cell which inhabits the protoplasm of the *Characeæ* ‡, it is at first uniformly clear and transparent, then semi-opake and subgranular, afterwards two or more distinct granules make their appearance, and finally it becomes wholly granular and much enlarged; or undergoes fissiparation and thus gives origin to more cells, like the cytoblast of the vegetable kingdom.

Use.—It is impossible, in the present state of our knowledge, to specify the uses of the nucleus. One point, however, is evident, that it appears very early in the development of the freshwater Rhizopoda, sponge-cell, &c.; and another, that it bears a close analogy to a similar organ in the vegetable cell, viz. the

* Ann. and Mag. Nat. Hist. vol. ix. p. 474 & 477.
† Die Infusionsthiere, &c. Taf. 4. fig. 24. 4to, Leipzig, 1854.
‡ Ann. and Mag. Nat. Hist. vol. xvii. p. 101, 1856.

cytoblast, which also is the primary organ of this cell; and therefore, perhaps, we might term it the presiding organ, or consider that such are its primary offices over the development and life of these cells respectively. If we trace it from the Rhizopoda into the vegetable kingdom, we shall find it occupying the very same position relatively in *Amœba* that it does in the cell of *Serpicula verticillata**. Thus, in some Amœbous cells which settled down from their spherical into the plane reptant forms, the following sequence from without inwards was distinctly seen: viz. 1st, the pellicula and diaphane; 2ndly, the molecular sarcode bearing the nucleus, and a layer of greenish granules *externally*; 3rdly, the aqueous fluid of the centre (figs. 1, 2);—and in the spine-cell of the leaf of *Serpicula*—1st, the cellulose cell-wall; 2ndly, the molecular protoplasm, in which are imbedded the green granules (viz. cells or organisms in which part of the protoplasm bears chlorophyll) and the cytoblast; 3rdly, the aqueous fluid of the centre (figs. 63, 64). The difference between cellulose and pellicula, and the absence of the vesicula, &c. are points which have so little to do with the analogy in question when the latter is followed up through *Astasia, Euglena, Navicula, Closterium*, &c. into *Œdogonium*, and *Nitella* to *Serpicula*, that very little doubt will, I think, then remain, of the offices of the nucleus in *Amœba* being similar to those of the nucleus of the plant-cell, whatever these may hereafter prove to be.—Here, again, I would return for a moment to the cause of sphericity in *Amœba*, and submit whether the cavity containing the distending fluid is that of the vesicula or the centre of the sarcode; since the aqueous cavity of the vegetable cell may then be analogous to the vesicula; for, as before stated, I have never been able to succeed in detecting the vesicula in *Amœba* when under a spherical form; although, the moment it becomes plane and polymorphic, this organ reappears, of its usual size, and endowed with its usual activity.

Much, however, as the nucleus may at first appear to be a presiding organ, there can be no doubt, from what will presently be stated, that its ultimate destination, in some organisms at least, is to pass into granules which become new beings.

Ovules.—This term will be applied to a number of discoid, or globular, nucleated cells, which appear together in the sarcode of some of the Infusoria. At an early stage in *Spongilla, Amœba, Euglypha, Astasia*, and *Euglena*, these bodies consist of a transparent capsule, lined with a faint yellow film of semi-transparent matter, which, subsequently becoming more opake and yellowish, also

* This aquatic plant is selected for comparison because the circulatory movement is well marked in the cells which occupy the body of the leaf, and the cytoblast and protoplasm in the spine-cells of the margin.

becomes more marginated or distinct, and assumes a nucleolar form. In *Spongilla* there is also a delicate, pellicular layer, which is endowed with a low power of movement (figs. 39 *h*, 40 *a*).

I first noticed these ovules in the seed-like bodies of *Spongilla*, where they are enclosed in transparent globular sacs*, each sac holding a greater or less number of ovules, which are discoid in form, of different sizes, and accompanied by a great number of active molecular granules (figs. 37, 38); and during the past year I have frequently seen such in *Amœba Gleichenii*, where they have been equally numerous, have borne the same characters, and have been accompanied by a number of active molecular granules, as in the transparent globular cells of the capsules of *Spongilla* (fig. 5.) They occur also in *Euglypha alveolata*†, congregated round the hyaline capsule of the *nucleus*, from four to fifty in number, and mostly of the same size, but always globular, and accompanied also, as in *Spongilla*, by molecular granules (fig. 26). Such ovules may also be seen similarly situated in *Difflugia tricuspis* (H. J. C.) and in *Arcellina dentata* (Ehr.); enclosed in the latter in an ovoid capsule, which nearly fills the test. In *Actinophrys*, also, they appear to have been seen by M. Nicolet, as will be mentioned hereafter.

Astasia and *Euglena* constantly become filled with discoid cells of a similar kind, but in those of the former I have seldom been able to distinguish the capsule from the internal contents, on account of their smallness and the incessant motion of the animalcule (fig. 46). In *Euglena*, however, they are very evident, and it is worthy of remark that each partakes of the form of the *Euglena* to which it belongs (figs. 50, 58). Thus in *E. acus* it is long and cylindrical; in *E. viridis* oblong, compressed (fig. 59); in *Crumenula texta* and *Phacus* circular, compressed, &c.

In *Spongilla* and *Amœba* these ovules follow the motions of the sarcode, in which they appear to be loosely imbedded; they also undergo partial transposition in *Astasia* and *Euglena*, but in *Euglypha* and *Difflugia* are chiefly located round the globular hyaline capsule of the nucleus, at the posterior part of the body (fig. 28),—a position which it is well to remember; for although apparently unconnected in all, with the nucleus and its capsule, and diffused generally throughout the sarcode in *Spongilla*, *Amœba*, *Astasia*, and *Euglena*, yet in *Euglypha* and *Difflugia*, which we shall hereafter find the best for typical

* Ann. and Mag. Nat. Hist. vol. iv. p. 87, 1849. Of the formation of the seed-like body, I need not say more here, than that it consists of a capsuled aggregation of ovule-bearing sponge-cells; while *Amœba* presents the same appearance, when pregnant with ovules, as one of these cells, and becomes capsuled singly.

† Dujardin, Hist. Nat. des Zoophytes, Atlas, tab. 2. fig. 9.

reference, they are undoubtedly developed in the neighbourhood of the nucleus, and therefore confined at first to a particular part of the body.

In many of Ehrenberg's enterodelous Infusoria it is not uncommon to see a number of defined globular bodies, of nearly equal size, and of a faint, opake, yellow colour, which closely resemble ovules,—*ex. gr. Amphileptus fasciola* (Ehr.), *Himantophorus Charon* (Ehr.), &c.; nor is it improbable that many of his Trachelina, which come near *Planaria,* possess ovules similar to those which are found in the latter; but, from being so much mixed up with the spherical cells, pass equally unnoticed while in, as well as when out of the body, under such circumstances. M. J. Haime, however, has distinctly seen instances in which these bodies have been ejected from Infusoria, and have passed into locomotive animalcules under his eye. Thus he states that in *Plæsconia* they form a group of from forty to fifty in the middle of the body, are round, issue one by one, remain tranquil some time, then develope two filaments, one in front, the other behind, and move about rapidly. In an "undescribed" species of *Dileptus* they are whitish, and form a wreath, extending almost throughout the whole length of the body, become yellow towards the anal extremity, where they pass out with the remains of the food, soon develope two opposite filaments, and move about rapidly. In *Paramecium aurelia,* M. Haime states that an ovary appears some hours before death, about the middle of the body, which becomes filled with about sixty little nuclei; these increase in size, burst the ovisac, and thus pass into the body of the parent, from which they finally escape by an opening in the tegumentary covering, formed by the diffluence of the latter, and the ovisac follows them *.

Spermatozoids.—This term is provisionally applied to granules which are originally developed from the nucleus in *Amœba, Euglypha,* and *Spongilla* (?). In *Amœba* the process appears to commence by an increase of size in the capsule of the nucleus, which becomes more or less globular; at the same time the nucleus itself becomes uniformly granular; the latter then increases in size, so as to occupy a third of the interior of the animalcule, and then undergoes, apparently, duplicative subdivision, for the mass is sometimes seen to present a *single* groove, which passes through the centre, and ultimately becomes divided up into several segments. These segments assume a circular compressed or globular form, and continue entire until the granules or spermatozoids of which they are composed become fully developed, when the latter acquire the power of locomotion, and

* Ann. des Sc. Nat. Zool. t. xix. p. 131, foot-note, 1853.

thus separate from each other; meanwhile the original capsule of the nucleus for the most part disappears (figs. 10–15). In this way, some individuals out of a group of *Amœba radiosa,* bearing such granules, were seen moving about, even when so reduced that hardly anything but their cell-wall, and the one or two spherical segments of the granulated nucleus that remained in its interior, were left; upon being delivered of which it may be presumed that they became effete or died (fig. 14). Sometimes these segments are evidently held together by a soft mucous cell, which, being polymorphic, assumes the form of *Actinophrys,* and thus exhibits a locomotive power (fig. 16); while at others the cell becomes firm, transparent, and spherical, and the granules do not leave it until they become endowed with locomotion (fig. 15). When the latter is the case, the spermatozoids may be seen, if fully developed, to be bounding about their respective capsules, while the capsules themselves are still rolled on in the sarcode of the *Amœba* under progression. At other times the whole mass of spermatozoids, all separated, and having left their capsules, may be seen to fill the body of the *Amœba,* whilst still under active polymorphism and locomotion. Lastly, the parent sometimes dies in this state, and then the mass of spermatozoids may be seen to undergo gradual disintegration, as the granules, by twos and threes, or more, disentangle themselves from the sarcode, and bound off into their new element. These granules or spermatozoids in *Euglypha* average about $\frac{1}{16000}$ to $\frac{1}{12000}$ of an inch in diameter; about four of them would make the diameter of the largest ovules, which are, again, somewhat less than human blood-globules.

In *Euglypha alveolata* a similar development takes place round the anterior part of the capsule of the nucleus (fig. 29); but from the concealed position of the latter, I have not been able to see it distinctly originate in the nucleus, as in *Amœba.* The segments here have always been compressed, probably from the soft polymorphic state of the mucous cell which encloses them admitting of their assuming a plane or reptant actinophorous form (fig. 31); and in this way they are carried out of the *Euglypha,* which, like *Amœba,* perishing on their development, and passing into decomposition, thus allows them to quit the parent cavity; at other times they separate close to the hyaline capsule of the nucleus, and finally swarm about in the test generally (fig. 29). Although this development, as well as that of the ovules, takes place more profusely in different individuals than in the same one, yet it is by no means uncommon to see, in a group of ovule-bearing *Euglyphæ alveolatæ,* individuals with both developments in them at once (fig. 30); and with no gradation in the size of the ovules to indicate that they originated in the granules, or *vice versâ*,—the two developments thus appearing distinct: and this seems to be confirmed by what takes place in a larger variety of this species of *Euglypha*, where there is a test something like that of the parent developed in the interior, and within this a spherical capsule, provided with a straight tube, which extends to the pointed end of the test in which it is immediately enclosed (fig. 32). At this time the animal has entirely disappeared, and the contents of the spherical capsule, having undergone segmentation, assume the form of circular masses of granules, like those developed from the nucleus in *E. alveolata*; after which the granules separate, and pass out of the straight tube, which is slightly patulous at its free extremity (fig. 33). Other tests of the same variety may be seen more or less filled with ovules, as before described.

Lastly, in *Spongilla*, there are always many cells to be found in that part of the mass where the seed-like bodies are being developed, partly filled with similar granules, loose or in a circumscribed group; but I have not yet been able to determine whether this development is nucleolar, or ovular at an early stage. It is certainly most like the granular development of the nucleus in *Euglypha* and *Amœba*.

In *Astasia*, irregular globular botryoidal masses, dividing up into spherical cells, colourless and translucent, or of a faint, opake, yellow tint, present themselves so frequently (and generally inversely developed with the ovules, as in the Rhizopoda), that I cannot help thinking that they are also developments from the nucleus (figs. 47, 48); but from not having seen them present that evident granular aspect which characterizes this development in the Rhizopoda, I have not been able to determine satisfactorily whether they are parts of the latter, or that kind of division of the sarcode into green spherical cells which sometimes takes place in *Euglena*.

In *Euglena*, also, I have described a development of the nucleus, partly under the idea that it might be a parasitic rhizopodous development; but now it appears to me to be a simple enlargement, granulation and segmental development of this body into polymorphic, reptant, mucous cells, filled with spermatozoid granules, as in the Rhizopoda*.

Finally: from what organs, in the freshwater Rhizopoda, *Astasia* and *Euglena*, are the ovules and the spermatozoid granules developed?

Of the origin of the latter from the nucleus there appears to me to be no doubt; for independently of the changes taking place in it which have been mentioned, I have never been able

* Ann. & Mag. Nat. Hist. vol. xvii. p. 115, 1856.

to see the nucleus and its capsule in their original form when the spermatozoid mass has been present, though I have occasionally, in *Amœba,* and almost always in *Euglypha,* seen the empty globular capsule in connexion with the latter. In *Amœba,* before the spheroidal divisions of the nucleus have separated from each other, they frequently appear in the form of a botryoidal mass, projecting from one part of the capsule.

But, as regards the ovules, although they are also unquestionably developed around the globular capsule of the nucleus in *Euglypha,* yet the fact of their being developed throughout the greater part of the sarcode which lines the cell of *Euglena,* and the same in *Astasia,* which is closely allied to *Amœba,* while in the latter they appear also to be developed from the sarcode generally, seems to indicate that they are developments of some part or parts of the sarcode—perhaps of some of the moleculæ. That the two developments, viz. that of the ovules and spermatozoid granules, present themselves together in *Euglypha,* has already been stated, and the fact of the ovules in *Euglena* first becoming developed outside the capsule of the nucleus, and the granular development of this body following it, shows that the ovules are not developed from the nucleus. The capsule, therefore, in *Euglypha,* under these circumstances, as well as when there are ovules alone present, is often seen minus the nucleus; and the same in *Amœba Gleichenii,* where it may be observed rolling about with the ovules when the latter have, for the most part, reached their largest size (fig. 5). In these instances, too, the granules of the nucleus, if the latter has undergone this transformation, may be dispersed among the general mass, as the nucleus on such occasions has, if not absent, appeared faintly marked, probably from having become effete or atrophied,—the ovules and spermatozoids appearing to be inversely developed; and in *Astasia* and *Euglena,* the former to be destroyed on the development of the latter.

Nicolet has stated that in *Actinophrys* the generative organs consist of a central spherical membrane, enclosing little globules, which are the rudiments of "eggs," surrounded by a "gelatinous granular layer," the granules of which appear to be the reproductive organs*. But this simple statement, though bearing the semblance of fact, is too meagre, without illustrations, to be of any use. If his "spherical membrane" be the same as our capsule of the nucleus, after the latter has become globular, then certainly the ovules are not contained in it in *Euglypha.* Stein also figures the nucleus of his *Actinophrys oculata* in accordance with Nicolet's observations, viz. with a granulated

* Comptes Rendus, vol. xvi. p. 115, 1848.

nucleus, fixed in a spherical capsule, surrounded by a zone of granular plasma (?) (fig. 95)*. This, as will be seen hereafter, is very like the state of the nucleus in the rhizopodous cell of the protoplasm of the Characeæ, when the former is undergoing reproduction.

With reference to the organs of generation in the other Infusoria, I can state no more than that although there is a fusiform nucleus in *Otostoma,* I have also constantly seen a bunch of string-like filaments floating about its interior, which appeared to be attached near the buccal cavity; and although I could make out nothing more, I could at the same time only liken these to the generative apparatus in the *Planaria* mentioned, which floats round the buccal cavity and upper part of the membranous stomach in a similar manner.

Impregnation.—In *Amœba* and in *Actinophrys* a union of two individuals is not uncommon, and many have noticed this in the latter. It has occurred to me, also, to see it in a species of *Amœba,* which, from its circular form, and the prolongations only taking place from one point of the circumference, appeared thus to present an anterior extremity, by which several pairs of the group were united (Plate V. fig. 17); and on one occasion two separated under my eye, when an attenuated prolongation of one seemed to be drawn out through a thick prolonged portion of the other (fig. 18). More convincingly and frequently, however, this union was observed in a group of *Euglypha,* where the anterior extremity of the body is distinct (figs. 34, 36). Here the protruded parts, after having been united for some time, began to separate by constriction at the point of contact, which, soon diminishing to a mere mucous thread, became smaller and smaller, and more elongated, as the two individuals, retreating from each other, withdrew themselves into the bottom of their test respectively, from which they appear on such occasions never again to emerge. Lastly, in a group of *Euglena deses,* several couples appeared united by the tails, not only to one another, but fixed to the watch-glass at this point, where they continued until each sank down, close to the other or separate, into capsuled forms filled with ovules,—a state which appeared so much the more to be the result of impregnation, from the number of couples thus united presenting every stage of ovigerous development in their interior, from mere molecular sarcode to repletion with full-formed ovules (figs. 49, 52). It is not an uncommon thing to see, among a group of *Euglenæ agiles* (H. J. C.), individuals chasing each other, becoming united head to head, head and tail, or tail to tail, and then separating with difficulty by a

* *Op. cit.* tab. 5. figs. 25–28.

whirling motion, as if the bond of union were a mucous thread, which could be only twisted off in this manner. Two *Euglenæ virides* may also sometimes be seen united by the intertwisting of their filaments only, just like the congress of two snails.

All these unions appear very much like so many acts of conjugation; but when we find *Euglypha* as well as *Arcella* united, not only in pairs, but triply and quadruply, in this way, and the same with *Euglena viridis*, the connexion of these phænomena with reproduction, as Claparède has stated *, becomes "exceedingly doubtful;" particularly as we have seen the spermatozoid granules developed from the nucleus and among the ovules; and this granular spermatozoid development, if it be one, does not take place until after conjugation. At the same time, in one group of *Euglyphæ*, nothing but spermatozoids were developed, while in another hardly anything but ovules appeared; and it was only here and there that both were found together; again, in the larger variety of *Euglypha*, the granules were developed in a distinct apparatus, and the ovules in the same manner as in *E. alveolata*, viz. in the posterior part of the body, outside the capsule of the nucleus.

Lastly, we come to the question whether or not these granules are spermatozoids? That the ovules in *Spongilla* pass into polymorphic cells, I proved by experiment some years since†; and lately, I have repeated similar experiments, with the same results. Moreover, I have seen the ovule of *Euglypha* in every stage, from its first appearance in the test to the time when it has acquired the power of putting forth rhizopodous prolongations (fig. 31), after which the tests of very small *Euglyphæ* presented themselves in the same basin, which did not appear before the parents had died off and left their ovules to shift for themselves. Hence this is one mode of propagation among the Rhizopoda, whatever the granules which we have provisionally called spermatozoids may be. Then, also, it has often occurred to me to see circular groups of spermatozoids undergoing disintegration or dehiscence in the test of *Euglypha*, while ovules were present, and granules like the former swarming round the latter at the same time; as well as granules of the same kind in *Amœba Gleichenii*, where the ovules have been far advanced in development. In *Spongilla* also similar granules abound in the transparent globular sacs of the capsules which contain the ovules (figs. 37, 38); and when the latter are set free by forcibly bursting the former, these little granules crowd round the large ovules so markedly that I made this observation several years since‡, when I little

* Ann. & Mag. Nat. Hist. vol. xv. p. 286, 1855.

† Idem, *loc. cit.* ‡ Idem, *loc cit.*

thought that there was any reason for thinking them organs of impregnation. Lately, however, I have observed, that full half the larger ovules of the seed-like body, under this condition, have one of these granules in different degrees of connexion with them, from simple approximation to almost undistinguishable incorporation (fig. 39 *a'–e*) ; also that when the internal contents granulate on the third or fourth day after they have been set free, the prominence caused by the appended granule does not disappear until the whole ovule has passed into a polymorphic cell (*h, l*) ; that is, that after this, no capsule or anything else remains behind, to indicate that the granule and its capsule, with this prominence, have not wholly become transformed into the new sponge-cell. This granule, however, is not entirely confined to the larger ovules, where it is for the most part affixed to the margin, but is also presented here and there by many of the small ones. In the larger ovules it bears, in size, the proportion of about one to eight, and the largest ovules average about $\frac{1}{3000}$th of an inch in diameter. About twelve hours after the ovules and granules have been set free in the manner mentioned, into distilled water, in a watch-glass, they, as well as the granules, exhibit a great deal of motion, which lasts up to the end of the first day, when they become quiet again ; and this motion, though least in the largest ovules and most in the smallest granules, is generally from one side to the other in all, like that of a zoospore which is attached to the glass by one of its cilia, or of a monad, which possesses a polymorphic coat attached to some body, and a moving single cilium. Some of the granules, however, every now and then appear to break away from this attachment, and then present a single (?) ciliary appendage, which ceases to be visible again the moment they become fixed. All the ovules, both those with which a granule is connected, and those without, appear to undergo a like granulation of their internal contents, and pass into new sponge-cells (*i, k, l*), which for a day or two remain polymorphic and reptant, and then assume a spherical actinophorous form ; while there is also a development of single (?) ciliated monads, closely resembling those which are found in the fully-developed sponge (*m*). In their reptant state, also, the former present the vesicula and frequently a single cilium.

Under what circumstances we are to view the incorporation of this granule with the sponge-ovule, I am ignorant*. Certain it

* It is just possible that these granules may be buds like those which appear on the so-called "ferment-cells" (fig. 44), but the latter grow into new cells as large as the old ones before they are detached, if even this takes place then, which is not the case with the granule attached to the sponge-ovule. Again, the ferment-cells are chiefly seen in pairs, from the bud in many having increased to nearly the size of the parent, while the sponge-

is, that one of these granules, which at first hardly appears to differ from the ovule itself, except in size and the addition, perhaps, of a single cilium, may frequently be seen to exhibit movements about a large ovule indicative of a desire to become incorporated with it; and frequently, also, it seems to succeed in fixing itself permanently to its circumference, before the eye; while occasionally a monociliated granule may be seen to be appended to one of the sponge-cells thus newly developed, in the same manner that the "zoosperm" attaches itself to similar cells in the old sponge (fig. 43).

In the absence, then, of direct evidence respecting the ultimate destination of these bodies, we must infer that they are germs, which grow into new individuals (perhaps like microgonidia*), or that they are impregnating agents, which enter into the ovules, and thus render them capable of further development, or both. Analogy, in connexion with the facts mentioned, seems to favour the latter view; for when we observe the development of the ovules, and these spheroidal or discoid segments of the granulated nucleus, which are of about the same diameter as the ovules, occurring together in the same *Euglypha*; and one cell, viz. that of the ovule, remaining entire, while the contents of the other, viz. the spheroidal segment of the nucleus, has apparently divided up into a number of locomotive granules, —the process so far accords with what takes place in higher organic developments during the process of true generation that we become much induced to extend the analogy still further, and consider that the contents of some of the spermatozoid granules or smaller cells go into this larger one to complete it, in the families of Rhizopoda, &c. mentioned. The monociliated cells ("zoosperms" †) of *Spongilla* might, perhaps, by some be considered young sponge-cells, which lose their cilium on further development; for such is the course with the monads which are produced from the rhizopodous cells of the protoplasm of the

ovules do not appear in this state. It is only when the buds of the ferment-cells are very small, that there is any direct resemblance between them and the sponge-ovules presenting a similar condition. If the granule in connexion with the sponge-ovule be a bud, it must be detached from the parent when very young, for there are no intermediate stages as in the ferment-cell to show that it is in reality one.

Again, the oscillation of the granule round the sponge-ovule may be a physical attraction; this oscillation, however, does not present itself among the ferment-cells, while in the sponge-ovule it appears to end frequently in a permanent attachment of the granule to the ovule,—a condition that may be aided by the "external layer" or diaphane envelope of the latter.

* See Braun on the reproduction of *Hydrodictyon*. Ray Soc. Pub. Bot. and Phys. Mems. pp. 89 & 261.

† Ann. and Mag. Nat. Hist. vol. xiv. p. 334.

Characeæ before they pass into *Amœbæ*; while the number of the former being as great in the first portion of sponge which issues from the capsule as in the older mass, if not more so, seems not only to support this view, but also that they do not all form part of the surface-layer of the canals in which cilia have been detected by Mr. Bowerbank, for at this period there are no canals present. The facts above mentioned, however, are opposed to this view; for there is a marked difference between the reptant sponge-cells produced from the ovules in the watch-glass, and the monociliated ones developed from the granules, both in size and appearance (*l, m*); and although the cilium subsequently seen in the former may have pre-existed in the ovule, still, both being polymorphic, rhizopodous cells, and, therefore, when united undistinguishable individually, the cilium might belong to either, *i. e.* to the sponge-cell or to the incorporated granule,—the latter of which may frequently be verified when examining a piece of *Spongilla* torn to pieces, under the microscope (fig. 43). Whether or not, however, both possess a cilium at first, the sponge-cell loses it afterwards, whatever may happen to that of the supposed zoosperm, which may not become incorporated with one; and this may be the case with the monads which are produced from the rhizopodous cell of the Characeæ,—there may be two kinds.

Should it be hereafter proved that the granules of the nucleus thus become impregnating agents, then this mode of generation may perhaps be extended through *Euglena* to *Navicula, Closterium, Spirogyra, Œdogonium,* and *Cladophora*; for in none of these Algæ has anything approaching to a process of generation been detected beyond conjugation and the formation of the spore; while, indeed, in *Spirogyra mirabile* (Hass.), *Œdogonium,* and *Cladophora,* the spore is formed without conjugation.—Might not the granulation of the nucleus, &c. go on in the spore?

In *Cladophora* the gonimic substance consists of nucleated cells, each containing a portion of green chlorophyll-bearing protoplasm, and these are arranged in the way of a pavement on the inner side of the cell; hence we must consider *Cladophora* a composite Alga, which would then form the first step to the cell of *Nitella,* in which the green chlorophyll-bearing cells would correspond to the same kind of organisms in the cell of *Cladophora*; but as the form of *Nitella* is more complicated, so it requires distinct organs of reproduction for its general development. That the conjectured mode of generation mentioned in the freshwater Rhizopoda may be the same as in the lower Algæ, and that the addition of other and distinct organs for this purpose in the higher developments is a necessary sequence of their complication, are observations merely put forth for what they may prove worth. At the same time, it appears evident that each organ must have its proper cell, and this cell its proper mode of impregnative reproduction, just as much as the most complicated beings of which it forms a part; while the granulating of the nucleus of a cell to furnish fertilizing germs for the process of generation, when a simple division of it only is required for common reproduction, is perhaps not the least untenable view that may be held on the subject.

In *Physactis saccata*, Kg., the spherical, terminal cell of the snake-like filaments is filled or lined with a homogeneous, translucent substance, in one part of the circumference of which is a nucleus, and this part is invariably next the last granuliferous cell of the filament (fig. 70 *b*), which with the four or five following ones unite together to form the elongated club-shaped sporangium (fig. 71). When the sporangium is completed, the spherical cell is seen to be united to it by a kind of neck, but the nucleus and its homogeneous contents have disappeared, that is, have passed into the sporangium (fig. 71 *a*). While here and there may be seen spherical cells unattached to (probably separated from) their filaments, some of which have a granular substance growing out in a linear form from the *nucleus* (figs. 72, 73). Hence then, as we have the *nucleus* of the spherical cell applied to the terminal cell of the granuliferous chain, a tubular prolongation connecting it with the sporangium, the disappearance of the nucleus and other contents of the spherical cell after the formation of the sporangium, together with a granular growth from the *nucleus* of this cell when the sporangium is in process of formation, I think it may fairly be inferred, that the chief part which the spherical cell adds to the sporangium is this granular growth from its *nucleus*.

Development of the Ovule.—In *Spongilla* and *Euglypha*, this appears to take place by the passing of the transparent, faint-yellow film, which lines the interior of the capsule, into an opake, yellowish, granuliferous membrane; synchronously with which it becomes more marginated towards the capsule, and presents, in the centre, a pellucid area, in the middle of which, again, is a minute granule or body, which appears to be the rudiment of the nucleus (fig. 59). Frequently, also, another layer, as before stated, is seen in the ovules of *Spongilla* external to the capsular one, and this appears to be endowed with locomotive power, as it generally presents a parabolical shape, extended out from one side of the ovule (fig. 40 *a*); after which the ovule in each becomes transformed, apparently wholly, into a polymorphic, reptant Rhizopod (fig. 39 *i*, *k*). The same process, modified, appears to take place in the ovules of *Euglena*. Thus in *E. viridis*, where they are of an oblong shape (and therefore unmistakeable, if nothing but a legion of this species pregnant with ovules be present), they are found like the ovules of *Spongilla,* viz. scattered over the sides of the vessel, and evidently have, in like manner, the power of locomotion in addition to that which both also possess of turning upon their long axis when otherwise stationary. This, perhaps, may be partly effected by the external membrane just mentioned. The pellucid central area in the oblong ovules of *E. viridis* corresponds with the oblong shape of the capsule (fig. 59); but beyond this, and the central granule, I have not been able to follow their development out of the parent; though, from the number of young *E. virides* which present themselves under the circumstances mentioned, it may reasonably be inferred that they come from the ovules. The young *Euglenæ,* however, being so rapid in their movements when once the cilium is formed, it can hardly be expected that, except under a state of incarceration, their development can be followed so satisfactorily as that of the slow-moving Rhizopod. Instances do occur, however, where the ovules gain the cilium within the cell, and there bound about, when fully developed, like the zoospores of Algæ within their spore-capsules. In this way I have seen them moving rapidly within the effete transparent capsuled body of *E. viridis* and in *Crumenula texta,* where the spiral fibre layer is so strongly developed as to retain the form of the *Euglena* for a long time after all the soft parts have perished. On these occasions the embryos are perfectly colourless, with the exception of a central point, which reflects a red tint; and on one occasion, while watching a litter in rapid motion within the capsuled body of *E. viridis,* the capsule gave way, and they came out one after another just as zoospores escape from the spore-capsule; but from their incessant and vigorous movement I was unable to follow them long enough to make out anything more about them. Kölliker also noticed in *Euglena* "four to six embryos in one individual, and entirely filling it, which at last, furnished with their red points and cilia, broke through their parent, leaving it an empty case*." The same kind of development of the ovule probably takes place in all the Rhizopoda as in *Spongilla,* and in *Astasia* as in *Euglena.* I have seen young *Astasiæ* in the effete body of an old one, but could not say that the latter was the parent.

To Stein's original and valuable observations on the development of embryos, arising from the division of the nucleus in *Vorticellæ,* I have already alluded; and also to M. Jules Haime's statements regarding the ovules which he saw in the bodies of

* Quart. Journ. Microscop. Sc. vol. i. p. 34, 1853.

Plæsconia, Dileptus, and *Paramecium aurelia.* Neither, however, appears to have seen ovules in either of these Infusoria sufficiently distinct to describe their composition in detail.

Lastly, I would advert here to the rhizopodous forms which *Vorticella* occasionally appears to assume when under gemmiparous reproduction. Stein has described it in *Acineta,* and I have since observed it in a Rhizopod undistinguishable from *Amœba Gleichenii*; I have also seen *Vorticellæ* developed *singly* from *Acineta*; and am now compelled to return to the conclusion which I doubted formerly, viz. that the rhizopodous development which takes place in *Euglena* is a similar passage of the nucleus, and perhaps certain other contents of this Infusorium, into a rhizopodous form*. It appears to be as general in the family of *Euglena* as in that of *Vorticella*; and although these two organisms at first look very different, yet not only is their metamorphosis into rhizopodous forms similar, but the sudden contractile movement at intervals of a species of *Glenodinium* (Ehr., very nearly the same as *G. tabulatum*) is so like that of *Vorticella,* and *Glenodinium* is so closely allied to *Euglena,* that we cannot help seeing in this act alone a feature which links together *Euglena* and *Vorticella,*—if not also, with other points of resemblance, the biphorous Tunicata or Salpidæ.

Hence then, as *Vorticella* may pass into *Acineta* or *Amœba,* and *Euglena* also into a rhizopodous cell, and the former may in its metamorphosis produce young *Vorticellæ,* so perhaps *Euglenæ* may produce young *Euglenæ* after a similar manner.

How, then, are we to regard this granulating development of the nucleus? We have seen that it occurs in *Euglypha,* where also there is a distinct development of ovules. Are we to regard it as the flowering of a diœcious male plant, or as the budding of a monœcious or bisexual flowering one,—as the impregnating element, or as a reproductive gemmiparous one? We can hardly consider it budding or gemmiparous, because it is a development of the nucleus itself, which allies it more to fissiparous or duplicative subdivision; and if this cannot be determined, perhaps it

* This was the original view I took of it. I then conceived it to be a foreign development, like the rhizopodous cell of the Characeæ, for it took place in several *Crumenulæ,* which had respectively been enwrapped for a short time in rhizopodous cells, when I thought the germs of the new development might have been introduced into them. Still I wavered in my opinion, as may be seen in the latter part of my description of this (Ann. and Mag. Nat. Hist. vol. xvii. p. 115), and since then I have returned to the old view, which is that above expressed; for independently of other evidence in favour of it, *Euglena* would be an exception to what now seems to be a general occurrence in organisms closely allied to it, that is, if we considered this granular metamorphosis of the nucleus into polymorphic, rhizopodous bodies, a foreign development.

had better be called "granulation." Gemmæ grow out from the surface, and do not appear to contain any portion of the nucleus (*ex. gr. Vorticellæ*)*; neither could I discover an elongated nucleus, as Stein has figured, in the *Amœbæ* and *Acinetæ* which I saw developing young *Vorticellæ*, the former in plurality (one to three), and the latter singly; if present in the amœbous form, it was circular, and if in the *Acinetæ*, undistinguishable from the general "granulation."

Again,—Where are these transformations to end? Into what kind of rhizopods do the *sheathed Vorticellæ* pass? How many of the freshwater Rhizopoda are alternating forms of *Vorticellæ*? How many actinophorous Rhizopods those of *Euglenæ*? How many more Infusoria pass into amœbous forms? &c. are questions originating in Stein's important discovery, which not only indicate the necessity of further investigation, but a considerable approaching change in the classification of Infusoria.

It is desirable, also, that I should add here what little more I have been able to collect respecting the development of the Monads in the rhizopodous cell, which dwells and multiplies in the protoplasm of the Characeæ †. This, it will be remembered, I conjectured to be by segmentation of parts of the diaphane and sarcode; but before making any further observations on the subject here, I will again premise a brief description of this cell. It is distinctly a Rhizopod, like *Amœba*, or the sponge-cell, but of greater tenuity, and without, so far as my observation extends, a vesicula; that is, I have not been able to recognize this organ in it, though on dying it presents vacuoles. The nucleus, as before stated, is clear at first, then becomes cloudy, and presents one or more defined granules, afterwards semi-granular and opake, and then uniformly granular throughout, when it appears to multiply by fissiparation in the parent cell, and thus to give rise to several daughter-cells, after the manner of a vegetable cytoblast; or to grow into an elongated granular body, of whose ultimate development, while within the living internode of the Characeæ, I am ignorant (fig. 93). But when the internode of *Nitella* (*ex. gr.*) is about to die, and this rhizopod seizes upon the green disks of the periphery and other nutritious matters of the interior, now deprived of the vitality which kept them together and thus exposed to the rapacity of the ascendant parasite, the nucleus undergoes various changes, which arrests of development at different stages, among the myriads which are

* A similar process takes place in the roots of *Chara*, where the new nuclei for the new buds come into existence in the protoplasm surrounding the old nucleus, but at some little distance from it, after which the old nucleus perishes.

† Ann. and Mag. Nat. Hist. vols. xvi. p. 10, & xvii. p. 115.

presented to view, seem to elucidate. Thus the nucleus with its capsule, now surrounded by the nutritive contents enclosed within the sarcode, enlarges and passes from its discoid form (elliptical in the large *Nitella*) into a globular one*: meanwhile the former becomes distinctly and uniformly granular; the granules enlarge and become refractive; they assume, *en masse*, a spheroidal form enclosed within a cell of their own, and thus become distinct from the capsule; at the same time one or more refractive (oil ?) globules, or a nucleus, may sometimes be seen in the latter. While this is going on, a zone of colourless plasma (?) forms all round the capsule of the nucleus, which thus becomes separated from contact with the now hardened cell-wall or pellicula, as well as from the diaphane and sarcode (fig. 94). The next stage is the bursting of the proper cell, and passage of the granules of the nucleus into its capsule, and from thence into the soft plasmic zone which surrounds it. After this, the plasma assumes a mulberry shape, and divides up into monads, which feed upon the enclosed nutritive matters, and are at length seen in the position of the sarcode and diaphane, now circumscribed by a transparent delicate membrane, the second pellicular cyst†. That the refractive granules of the nucleus, and portions of the enclosed nutritive contents, which are coloured brown by the dead chlorophyll, get into the bodies of the monads, cannot be doubted, as such matters are seen in them, and could come from no other source. Frequently, however, cells may be seen, apparently under an arrest of development, in which the plasmic zone has assumed a subtuberculated or mulberry form, and the granules of the nucleus are still in their globular cell within the capsule; hence it may be inferred that the segmentation of the plasma commences before the granules of the nucleus get into it (fig. 96). Again, in a more advanced but still arrested stage, the capsule of the nucleus is seen to be empty, and its bright granules, in the little pouches or mulberry-shaped excrescences of the plasma, now reduced to a mere membrane by arrest of development (figs. 97, 98). From which it may also be inferred that each pouch, which represents a monad, receives one or more of the granules of the nucleus. Does the tuberculated or mulberry

* I must infer this, because the nuclei in the large species of *Nitella*, as well as in *Chara verticillata*, are all elliptical.

† Is this degenerated pellicula and diaphane, or a new cyst, composed of the former only? I am now inclined to the latter theory, here as well as in *Otostoma* (Ann. and Mag. Nat. Hist. vol. xvi. p. 108 & xvii. p. 118 respectively), and that in *Otostoma* the ciliated coat is divided up for the new litter, while in the rhizopodous cell of the Characeæ the diaphane and secreting organ of the pellicular cysts become effete and pass into dissolution. (See the discussion on this point *ante*, pp. 117, 118.)

surface of the plasmic zone, thus under an arrest of development, indicate that it has taken this shape from consisting originally of a number of ovules enclosed within a globular membrane; and if so, is the passage of the granules of the nucleus into them to be considered an act of impregnation? If they were ovules, then one would think that there would be no occasion to lay up extraneous nutrition for them, more than in *Euglypha, Spongilla,* &c., the ovules of which, after the parent perishes, remain for a certain time in the effete body, and ultimately undergo a kind of incubation generally after they have left the cavity in which they were developed. Again, though very much like the granulating of the nucleus in *Euglypha* and *Amœba,* where the bodies which are thus evolved singly or in groups generally become endowed with active locomotive power before they leave the parent; yet in these instances no plasmic zone around the nucleus preparatory to this has been observed*. In the present stage of our knowledge, therefore, we are not able to say whether this be a gemmiparous or a generative process; whether monads developed in this way are merely multiplied zoosperms of this organism, or the mixed product of a genuine generative process; whether there be, in addition, an ovular development, as in *Euglypha,* &c.; or whether the monads thus developed soon perish, or become new cells. Certainly in *Spongilla* there are two kinds of developments, viz. the so-called zoospores or monads, and the transformation of the ovules directly into the sponge-cell: both are polymorphic, and at first have each (?) a single cilium; but one being much smaller than the other, they may perhaps be regarded respectively as macrogonidia and microgonidia, as Braun has suggested for the zoospores of *Hydrodictyon*†. From whence, then, come the so-called zoospores in the latter—from the granules or the nucleus?

Lastly, there are two organs in those *Euglenæ* (mihi, which for no just reason Dujardin has separated from this family), viz. *Phacus* (Ehr.) and *Crumenula texta* (Duj.), that I should notice here, though I am perfectly ignorant of their use. These are the so-called "red spot," which in *Crumenula texta,* where it is comparatively very large, rests in the form of a small obtuse cone upon the vesicula; and the glairy capsuled body, which always exists in the centre of *Phacus,* and in the long lip of *Crumenula texta,* &c.;—in some *Euglenæ* there is an undefined yellowish body here.

Of what use the "red spot" or body may be, I am ignorant; but it is very common to see matter like that of which

* *Actinophrys oculata* (Stein), however, presents a nucleus and plasmic zone of this kind. (See p. 228.)

† Ray Soc. Pub. Bot. and Phys. Mems. *loc. cit.*

it is composed multiplied throughout the body of *Euglena,* both in an amorphous and molecular form, or, when nothing but the ovules remain in the colourless, transparent, fibrous cells of the two species mentioned, to see little granules of it moving with a more than Brownonian motion among the ovules. Ehrenberg regarded it as the rudiment of a visual organ; and perhaps he is right, for there seems to be very little difference between the pigment of the skin of a Negro and the pigment of the choroid membrane of his eye, while the latter is confined to the eye alone in white-skinned people. Again, in some of the Rotifera, it is not uncommon to see the material of which the red pigment of the eye is composed, more or less dispersed in a molecular form, though it is generally confronted by a bluish refractive matter, corresponding perhaps to the vitreous humour and lens. Also, in the so-called blind *Planaria,* there are organs like eyes with flat corneæ, but no pigment; and when the animal is about to divide into two across the stomach, the first indication appears to be an inversion of the integument which is to form the future eye, and at the same time a covering of it with cuticle, which thus supplies the cornea. Finally, then, as we find in the Albino eyes capable of seeing without the presence of pigment; the eye formed by an induplication of the skin; the pigment dispersed over the body, as well as in the eye, in the Negro, while it is confined to the eye in the white races,—we are led to the conclusion that the red body in the family of *Euglena,* though not necessarily indicating sight, may nevertheless mark the point where something of this nature exists in this, as well as in other Infusoria of the kind, although, as in *Astasia,* it is not similarly marked, any more than in many animals wherein a visual organ is present without this accompaniment.

In a small species of *Euglena,* which dwells in the brackish water of the main-drain of Bombay, and which, after having been placed in fresh water, assumes the still, Protococcus form, multiplying itself by fissiparation and internal segmentation of the sarcode, after the manner of vegetable cells, and occasionally in linear arrangement, like the filamentous Algæ,—the red body is as often omitted as repeated in each cell; while in the active state, previous to *longitudinal* deduplication, the red body always becomes dual, one on each side the vesicula. But in transverse fission it is frequently absent in the lower half, and only remains in the longitudinal divisions of the *anterior* one (fig. 62 *a–d*). It is interesting, too, to observe that this body is present in the gonidia of *Ulothrix zonata,* one of the filamentous Algæ, and that it also is confined to the first cell in fissiparation, which so far corresponds with *Euglena,* that when the latter assumes a fixed or algoid form, by capsulation, the peduncle of the pellicula is extended from the anterior, ciliated extremity. This also is the part which developes the root-like prolongations in *Œdogonium*; and probably the gonidia of *Ulothrix* grow after the same manner; in which case the red body would remain in the inferior half, and not be repeated, as in *Euglena*, when the latter fissiparates, in the still form, transversely.

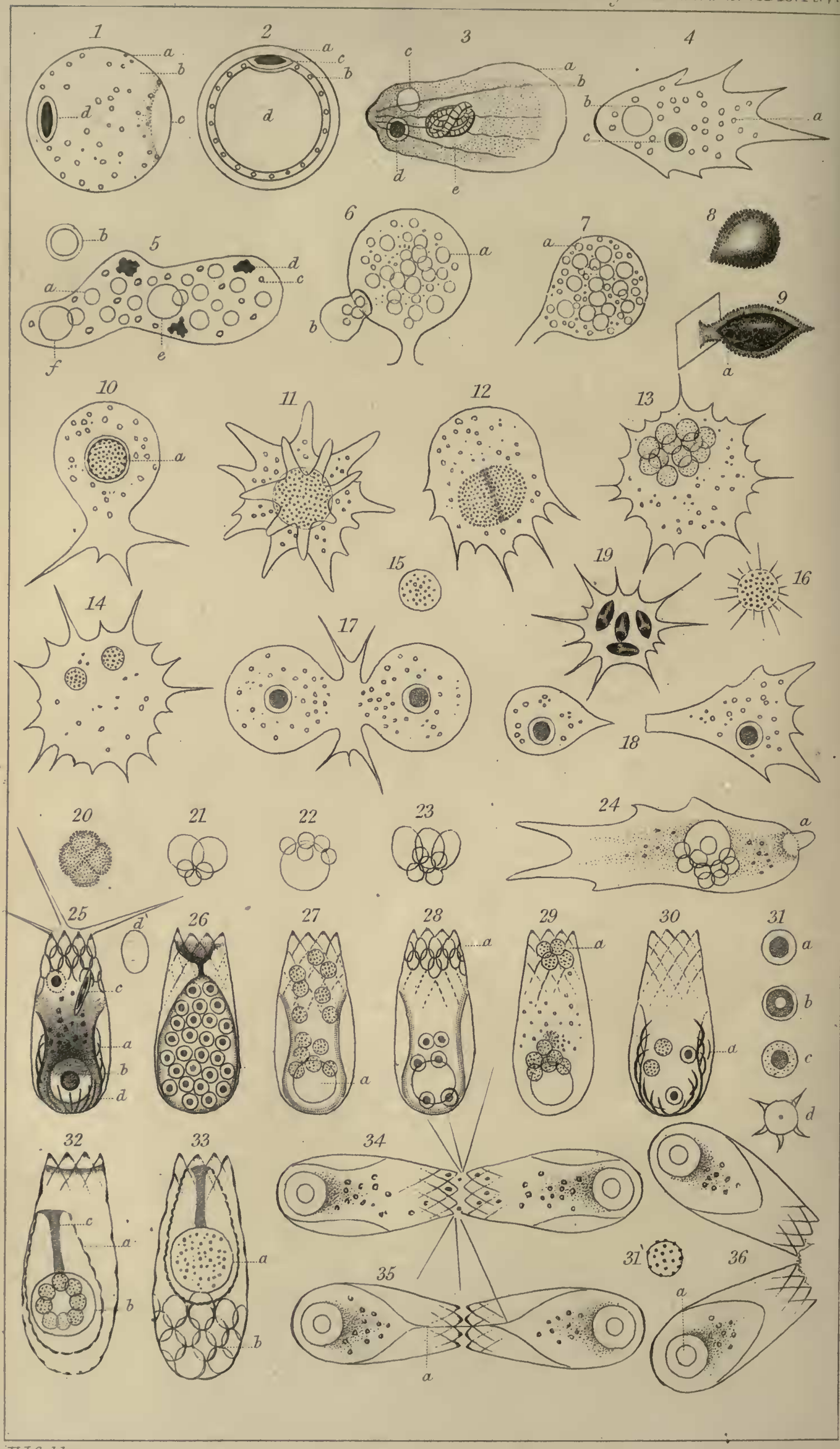
With reference to the single, glairy, capsuled body which exists in the centre of *Phacus*, and in the large lip of *Crumenula texta*, also dually in *Euglena geniculata* (Duj., *spirogyra*, Ehr.), one on each side the nucleus (figs. 53 *a*, 87 *a*, 88 *a*), I can state nothing further than that in the two first it consists of a discoid transparent capsule, which at an early stage appears to be filled with a refractive, oily-looking matter; that it is fixed in a particular position, and remains there apparently unaltered, with the exception of becoming nucleated, until every part of the animalcule has perished, and nothing is left but the spiral-fibre coat, and perhaps a few ovules. In *Euglena geniculata* it is bacilliform, and contains a correspondingly-shaped nucleus; and although I can state nothing respecting its uses, I cannot fail to see that it has an interesting analogy, particularly in the latter instance, with two similar organs, which are commonly seen in the *Naviculæ*, and which in *N. fulva*, *ex. gr.* are situated in a variable position, between the nucleus and the extremities on either side (fig. 89. In this species they make their appearance as little specks, generally previous to the development of the oil-globules, &c., and, enlarging rapidly, assume a globular form, consisting of a transparent capsule, enclosing a glairy, refractive, oily-looking fluid. As the starch and oil-globules are developed and subside, these glairy globules become distinctly nucleated, sometimes irregular in form, or pedicled to the endochrome-bearing protoplasm, and, like their apparent analogues in *Crumenula*, &c., remain in the frustule when everything else has become decomposed, or has passed into minute brown-red granules (sporules ?), when they present a central, glairy, circular nucleus, surrounded by a double globular capsule, neither of which, like the globule in *Crumenula*, takes any colouring from a solution of iodine. I need not here go further into the description of this organ in *Navicula*: suffice it to say, that it also appears constantly in a large species of *Amphiphora* common in the brackish water of the main-drain of Bombay, where it assumes the form, when fully developed, of an elliptical body, terminated at each end by a compressed, truncated, or obtuse elongation, like a barrel, and is always attached to the circumference of a vesicle (fig. 90 *a, a*). I should not have written so much about this organ here, but as it is not (as, I think, is generally supposed) a common oil-globule, and we know so little of the organology of the *Diatomeæ*, while its occurrence in *Navicula* seems to add to the other points of alliance which exist between the *Diatomeæ* and *Euglenæ,* its mention may not prove useless or uninteresting to those who are engaged in these studies. Perhaps for the present we had better call it the "glair-cell."

Here I should not omit to add, that the resting-spore or macrogonidium (Braun) of *Œdogonium* developes a number of capsules like the ovules of *Euglenæ*; and that though they occasionally exhibit, under the action of iodine, a blue tint, indicative of their amylaceous nature, yet when fresh and newly formed, they only take the brown-yellow one invariably presented by the ovules of *Euglena* under the same circumstances. Similar colourless capsules may also be seen moving about cells of *Œdogonium* whose contents have left their walls, and appear to have partially progressed towards that of the spore, without having had strength to assume the globular form; and these very much resemble the ovules of *Crumenula* when moving by the aid of a cilium within the effete transparent cell. All must allow, from what I have stated respecting the cell-contents of *Œdogonium flavescens* (Kg.), viz. that under favourable conditions, when the cell is broken, they can leave it bodily, form into a spore, and swim about by aid of their cilia, and that the germs of *Œdogonium* can pierce the sheath of *Oscillatoria princeps* (Kg.), and germinate between its cells, that these are phænomena of a kind much more common in the animal than in the vegetable kingdom.

In conclusion, I have only to remark, that the reader is requested to view all speculative suggestions in this summary of my "Notes" as mere cursory observations, introduced for the purpose of calling attention to subjects which are deemed worthy of consideration; the study of this part of organic creation being so much in its infancy, and so intricate, that hardly anything but that which has received ocular demonstration should be taken for *fact.*

P.S.—The following is a good illustration of what I have just stated. Since writing the above, I have seen numbers of "pores" in the investing membrane of *Spongilla,* open, remain so, and close; admit currents of water, as proved by the presence of particles of carmine; which particles were found to have been taken into the bodies of the sponge-cells and so-called "zoosperms," and afterwards thrown off again as the refuse of food by *Amœba.* This last fact establishes the animality of *Spongilla.* The "pores," at times, appear to be generally closed; hence the error of my having supposed this with a single vent to be the typical form of the investing membrane of *Spongilla,* and the consequent inference, that it was thus supported by endosmosis. I shall have to recur to these facts more particularly hereafter.

Bombay, 10th June 1856.



H.I.C. del.

J. Basire, sc.

EXPLANATION OF PLATES V., VI., VII.

Plate V.

Fig. 1. Amœbous cell under spherical distension, about to become planiform, from the brackish water in the marshes of the island of Bombay; 1-400th of an inch in diameter: (*a*) pellicula and diaphane; (*b*) sarcode and granules; (*c*) space unoccupied by sarcode; (*d*) nucleus in its capsule.

Fig. 2. Section of ditto through the nucleus, showing the same parts marked with the same letters: (*c*) nucleus; (*d*) central cavity now distended by water.

Fig. 3. *Amœba quadrilineata,* H. J. C. (n. sp.?), under reptation: (*a*) diaphane; (*b*) moleculæ of sarcode; (*c*) vesicula; (*d*) nucleus and capsule; (*e*) digestive globule containing a fragment of *Oscillatoria.*

Fig. 4. *Amœba Roeselii* (?), Duj.: (*a*) "granules;" (*b*) vesicula; (*c*) nucleus.

Fig. 5. *Amœba Gleichenii* (?), Duj.: (*a*) discoid ovules of different sizes, the largest 1-2800th of an inch in diameter; (*b*) one more magnified showing the capsule; (*c*) "granules;" (*d*) portions of food; (*e*) capsule of nucleus empty; (*f*) vesicula. Animal about 1-400th of an inch in diameter when spherical.

Figs. 6–8. Ditto, becoming capsuled. 6. First stage, all extraneous matter thrown off, peduncle formed, but pellicula still admitting of (*b*) expansions; (*a*) ovules and granules. 7. Capsule too much hardened to admit of expansions of the diaphane. 8. Capsule formed, rough, yellow, about 1-300th of an inch in long diameter.

Fig. 9. *Euglena* (*viridis,* mihi), Ehr., encapsuled, capsule rough, of a yellowish-brown colour: (*a*) red-body next the peduncle.

Figs. 10–16. *Amœba radiosa* (?), Duj., showing nucleus in different stages of "granulation." 10. (*a*) nucleus enlarged, granular. 11. Nucleus still more enlarged, (12) presenting first sulcus of duplicative (?) subdivision. 13. Same process ending in the production of a mass of spherical, delicate, transparent, granuliferous cells. 14. Parent nearly effete with only two of the spherical cells remaining, the granules of which have become large, free, separated from each other and endowed with rapid locomotive power. 15. One of these cells more magnified. 16. Plane or actinophorous form of ditto previous to hardening of the pellicula and development of the granules.

Fig. 17. Ditto in conjunction.

Fig. 18. Ditto, another pair, just after separation.

Fig. 19. Actinophorous form of a species of *Palmellea* (?), Kg., like *Glœocapsa granosa,* Kg., but with cells, separate and solitary.

Fig. 20. Nucleus of *Amœba* under "granulation," presenting the second sulcus of duplicative subdivision.

Figs. 21–23. Different forms of botryoidal granuliferous cell-development of the nucleus in *Amœbæ.*

Fig. 24. *Amœba Roeselii* (?), Duj., presenting a nucleus undergoing botryoidal development: (*a*) mammilliform projection of vesicula preparatory to discharging its contents.

Fig. 25. *Euglypha alveolata,* Duj.: (*a*) sarcode, granules, and moleculæ; (*b*) nucleus and capsule (the former very seldom visible except in young individuals); (*c*) particles of food; (*d*) supernumerary scales; (*d'*) form of scale. Average length of full-grown test 1-400th of an inch.

Fig. 26. Ditto, with body transformed into an ovisac filled with ovules. Ovule about 1-4000th of an inch in diameter.

Fig. 27. Ditto, presenting a development of delicate granuliferous cells like those of *Amœba radiosa.* Cells about 1-4000th of an inch in diameter: (*a*) capsule of nucleus which generally remains entire.

Fig. 28. Ditto, showing that the ovules are developed outside the capsule of the nucleus: (*a*) opercular closure of the test accompanying these developments.

Fig. 29. Ditto, showing a separation and development of the granules into moveable bodies (spermatozoids?) *within* the test: (*a*) group of cells entire on their passage outwards. This and the last figure also show the development of the ovules and granuliferous cells in the neighbourhood of the nucleus and its capsule, and the latter apparently growing out of the nucleus.

Fig. 30. Ditto, showing ovules and granuliferous cells developed in the same test, and together: (*a*) supernumerary scales.

Fig. 31. Ovule of *Euglypha alveolata* more magnified: (*a*) showing capsule and nuclear portion; (*b*) ditto with pellucid area and central granule; (*c*) bearing granules. Do these granules indicate an approaching development of the sarcode, or are they adventitious? They do not appear in the early state of the ovule, but generally before it has left the test, wherein granules like those developed from the granuliferous cells are frequently seen oscillating round them. (*d*) development of external layer or diaphane, now giving the ovule a rhizopodous form. 31'. Granuliferous cell more magnified; in this state it progresses under a plane, actinophorous form, or the granules become large, separate, and exhibit much activity within the test.

Fig. 32. *Euglypha alveolata* (large variety?), 1-300th of an inch in length, showing a special apparatus for the development of the granuliferous cells: (*a*) animal (?) transformed into a secondary test; (*b*) cyst containing granuliferous cells; (*c*) tube for their liberation when they have become locomotive. The same is seen in the common or smaller variety.

Fig. 33. Ditto, ditto, with the granules separated and endowed with active locomotive power: (*b*) shows the structure of the test of *E. alveolata.*

Fig. 34. *Euglypha alveolata* in conjunction; the granules of each passing freely backwards and forwards into each other's tests, as if the two bodies had been two drops of water thus united. The union however is only apparent, as we see in the separation of *Arcella vulgaris*, which also exhibits a similar conjunction both still and under reptation.

Fig. 35. Ditto, ditto, separating: (*a*) the bond of union reduced to a mere thread.

Fig. 36. Ditto, separation of the fleshy substance completed, tests still united: (*a*) nucleus in its capsule.

Plate VI.

Fig. 37. Globular sac of seed-like body of *Spongilla*, partly filled with ovules and granules, of different sizes.

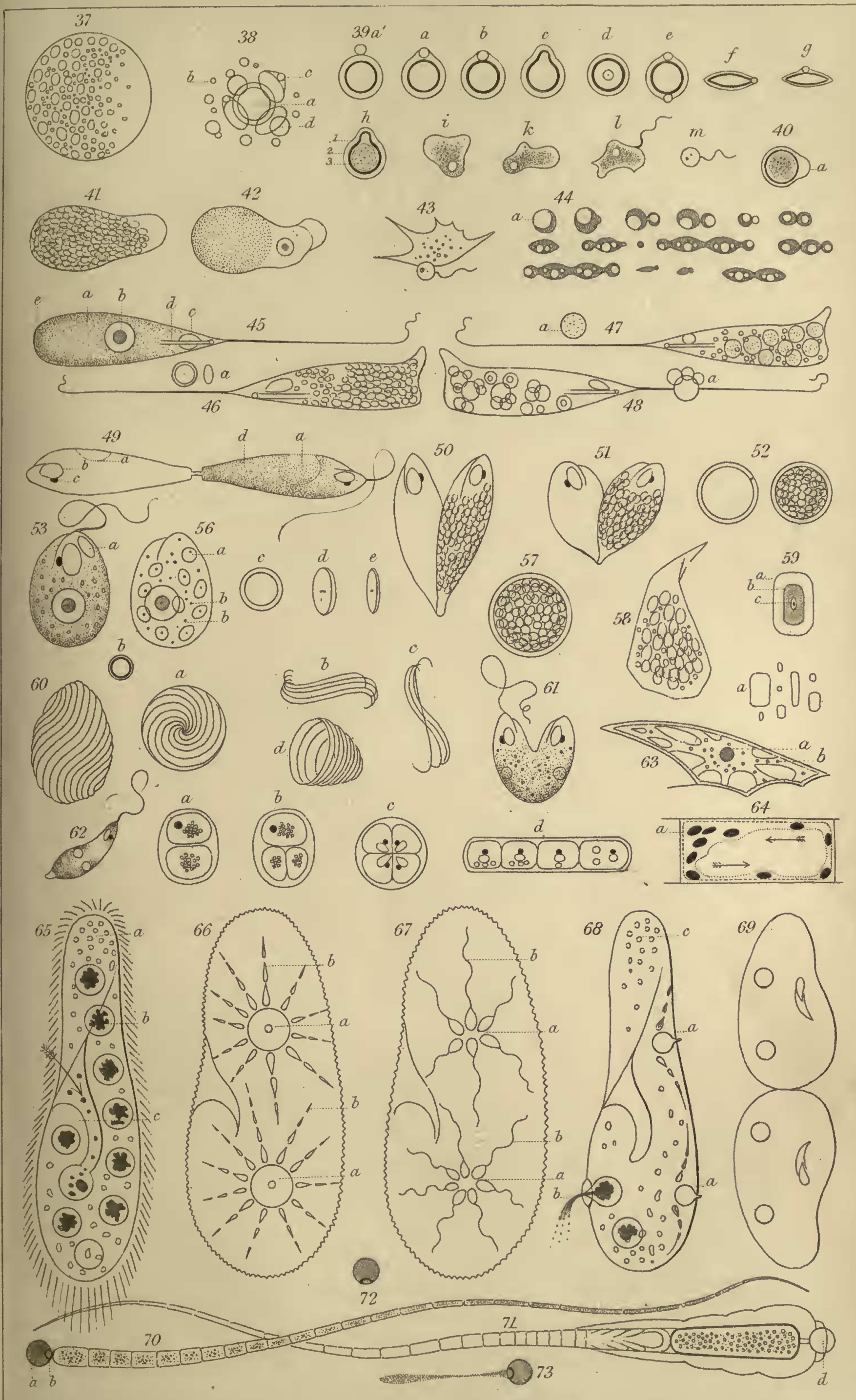


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Fig. 38. Portion of contents of ditto more magnified: (*a*) largest ovule of the group presenting the type of the whole, viz. that of a nearly colourless cell within a transparent capsule; (*b*) granules; (*c*) ditto in connexion with ovules; (*d*) ovules without a granule. Largest ovules 1-3000th to 1-2000th of an inch in diameter.

Fig. 39. Series of ovules of *Spongilla* to show the different degrees of approximation of the granule. 39 *a'–c*. Where the granule is adherent to the margin; (*f*) marginal view of ditto; (*d*) when adherent to the flat surface of the disk; (*g*) marginal view of ditto; (*e*) two granules in connexion with one ovule; (*h*) development of the ovule in connexion with a granule which appears to open into the cavity of the capsule, within which the granular sarcode is making its appearance; (*i*) next stage of development, in which the ovule has become slowly polymorphic and presents a vesicula; (*k*) when the polymorphism is more active; (*l*) ditto, presenting a cilium; (*m*) granule (?) transformed into a monad precisely like the "zoosperm." All these developments take place in three to five days after the ovules have been pressed out of the seed-like body into distilled water in a watch-glass.

Fig. 40. Ovule of *Spongilla* in progress of development to show the presence of the external layer or diaphane extending from it in a parabolic form. (It may here be asked, "what becomes of the 'capsule' which is originally so well defined?" This line of demarcation between the diaphane and sarcode disappears as soon as the ovule becomes polymorphic.)

Fig. 41. Ovi-bearing sponge-cell, still polymorphic, from the seed-like body at an early period, viz. before the capsule is formed. Spherical form 1-700th of an inch in diameter.

Fig. 42. Form of a sponge-cell which exists in a layer around the young uncapsuled seed-like body, and probably constructs the capsule.

Fig. 43. Small sponge-cell with so-called "zoosperm" attached, from an old piece of *Spongilla.*

Fig. 44. Group of so-called "ferment-cells" from the juice (*vulg.* "toddy") of *Cocos nucifera,* under fermentation; to contrast with the apparent budding development of the ovule of *Spongilla*: (*a*) vacuoles which abound in all these cells. Largest, circular cells 1-2000th of an inch in diameter.

Fig. 45. *Astasia limpida,* Duj., previous to the formation of ovules: (*a*) molecular sarcode; (*b*) nucleus; (*c*) vesicula; (*d*) buccal tube or proboscis; (*e*) position of anal orifice (?). Length about 1-438th of an inch.

Fig. 46. Ditto, filled with discoid ovules, of which few are ever found so large as the largest of *Spongilla*; they are generally about 1-6000th of an inch in diameter: (*a*) more magnified view of ovule showing its capsuled character.

Fig. 47. Ditto, containing spherical granuliferous cells like those of *Amœba* and *Euglypha.* Ovules atrophied as in *Crumenula texta* under similar (?) circumstances (see Annals, vol. xvii. pl. 9. figs. 11–13): (*a*) granuliferous cell more magnified.

Fig. 48. Ditto, with a botryoidal development (of the nucleus?) of similar cells: (*a*) bunch more magnified.

Fig. 49. *Euglena viridis* in conjunction previous to the formation of ovules: (*a*) position of nucleus and capsule; (*b*) vesicula; (*c*) red body; (*d*) molecular sarcode. Length of largest individuals 1-200th of an inch.